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APPLICATION FOR UNITED STATES LETTERS PATENT

FOR

RELEASABLE WIRELINE CABLEHEAD

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Cross Reference to Related Applications

This application claims the benefit of U.S. Provisional Application No. 60/426,897, filed November 15, 2002.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to wireline operations in a well and more particularly to a cable head system for remotely releasing a wireline from a downhole tool.

2. Description of the Related Art

Wireline operations are carried out in oil and gas wells for conveying tools downhole in the well. A wide variety of downhole tools may be supported on a wireline including tools to perform logging, perforating, and setting and retrieving operations. The tools typically comprise a combination of different tubular members threaded together to form a working unit which is manipulated and controlled from the surface via the wireline. Although tools may be conveyed downhole on a tubing string which can withstand substantially higher extraction forces than a wireline, oftentimes a wireline is preferred because it saves substantial rig time in conveying tools downhole and positioning them within the well. A cable head, which connects the tools to the wireline, is typically provided with a release mechanism to permit the wireline to be disconnected from the tools, such as when the tools become stuck downhole.

The commonly accepted safe operational pull of the wireline is a pull which does not exceed one-half the breaking strength of the wireline. When a tension is placed on the wireline which is over 50% of its break point, then problems begin to occur with the electrical conductors in the wireline. Also, there is the danger of breaking the wireline.

A typical wireline release utilizes a mechanical weak point in the connection between the wireline and the cable head. Typically this is a metal member which is designed to break upon a predetermined pull on the wireline. The correct conventional mechanical weak point must be calculated and installed prior to running the cable head and tools into the borehole on the wireline.

There are two limitations in using the typical mechanical weak point release, one is the strength of the wireline itself and the other is the strength of the mechanical weak point. For example, when the tool is stuck, the operator will fish for the tool with the wireline still attached to the tool in the hole. The operator lowers a grapple on a separate line, such as a slick line, which grabs the top of the cable head or the tool body. Once the tools are grabbed, the operator wants to release the wireline from the tool and remove it from the hole. Removing the wireline makes it easier to pull the tools and pipe out of the well. In order to effect the release, the operator places a large tension on the wireline to activate the typical mechanical release. If the cable head and tools are in a deviated hole, the effects of friction on the wireline may prevent the mechanical link at the cable head from receiving sufficient tension to break the link. In fact, the wireline may break at some uphole location before the mechanical link breaks. The presence of the broken wireline substantially impairs the fishing operation for the stuck tool.

Various other apparatus and methods have been provided for releasing the wireline from the cable head and tools. One common method of releasing the wireline includes the use of a spring set at a particular tension. Once the force on the spring is exceeded, the wireline is released. This release still requires that the amount of load required to release the wireline be predetermined prior to lowering the cable head into the well. If the spring tension is exceeded, there can be a premature release of the cable head.

Another typical release relies primarily on shear pins or shear screws. Problems are encountered with shear screws having a low failure point because they are exposed to various cyclical forces which tend to affect their ultimate shear rating. The shear screws are exposed to fluids in the well which over time can affect the inherent strength of the shear screws or pins making them susceptible to failure at stresses below their rated failure point. Unexpected release can significantly delay operations, causing additional operating expense. An unexpected release can also result in the loss of downhole tools and in extreme cases can cause severe damage to the wellbore requiring substantial time and money to repair.

Major problems occur if the cable head and tools get stuck in the well and the wireline breaks upon pulling on the wireline with too much tension. Breaking the wireline and dropping the wireline in the well greatly complicates the fishing operation to retrieve the tools.

Therefore, there is a demonstrated need for a remotely actuated cable release system that does not primarily rely on pulling a tension on the wireline to break a mechanical link.

SUMMARY OF THE INVENTION

The present invention addresses the above-noted and other deficiencies of conventional release mechanisms and provides a releasable wireline cable head.

In one embodiment of the present invention, a system for use in a wellbore, comprises a wireline extending from a surface location to a predetermined location in the wellbore. A tool string has at least one tool adapted to perform at least one downhole operation. A cable head releasably connects the wireline to the tool string.

In one aspect of the present invention, an apparatus for releasably connecting a wireline to a downhole tool comprises a first member adapted for connection to the downhole tool and a second member adapted for connection to the wireline. A plurality of locking elements are constrained to engage the first member and the second member by a moveable release member, where the plurality of locking elements maintain the first member and the second member in a connected position when the moveable release member is in a first position. An actuator moves the moveable release member to a second position, releasing the plurality of locking elements from engagement with the first member and the second member. This allows the first member and the second member to release the wireline from the tool.

In another aspect of the present invention, a method of releasably connecting a wireline to a downhole tool comprises locking a first member to a second member by using a release member to constrain a plurality of locking members to engage the first member and the second member, when the release member is in a first position. This maintains the first and second in a locked position. The release member is moved from the first position to a second position, thereby releasing the plurality of locking members from engagement with the first member and the second member. This releases the first member from the second member and allows the wireline to be released from the downhole tool.

Examples of the more important features of the invention thus have been summarized rather broadly in order that the detailed description thereof that follows may be better understood, and in order that the contributions to the art may be appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form the subject of the claims appended hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

For detailed understanding of the present invention, references should be made to the following detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings, in which like elements have been given like numerals, wherein:

Figure 1 shows an elevation view of a well logging instrument being deployed in a wellbore;

Figure 2 shows a cross section of a cable head according to one embodiment of the present invention;

Figure 3A shows a cross section of a latching mechanism in the locked position according to one embodiment of the present invention;

Figure 3B shows a cross section of a latching mechanism in the released position according to one embodiment of the present invention; and

Figure 4 shows a cross section of a latching mechanism according to another preferred embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to **FIG. 1**, there is shown a cable head **10** supported by a wireline **12** from a rig **14** at the surface **16**. The releasable cable head **10** supports a tool string **18** disposed adjacent a production zone **22** located, as for example, near the bottom **24** of borehole **20,** also called a wellbore. The wireline **12** is deployed from the reel **29** on the wireline vehicle **28** around one or more sheave wheels **26** down the borehole **20**. The wireline vehicle **28** has instrumentation, well known in the art, for communication and control of the cable head **10** and the tool string **18** . Such instrumentation may include a surface controller for remotely operating the cable head **10**.

The wireline **12**, sometimes referred to as a cable, typically includes a plurality of electrical conductors extending from the wireline vehicle **28** to the cable head **10**, all well known in the art. One such type of multi-conductor wireline **12** includes an inner core of seven electrical conductors covered by an insulating wrap. An inner and outer steel armor sheath is then wrapped in a helix in opposite directions around the conductors. The electrical conductors are used for communicating power and telemetry between the wireline vehicle **28** and the tool string **18**. Alternatively, the wireline cable may contain a combination of electrical conductors and optical fibers. A single electrical conductor cable may also be used. The tool string **18** may include logging tools, perforating guns, packers, and/or any other device suitable for running on a wireline and performing downhole operations.

Figures 2 and, **3A,B** show one preferred embodiment of the releasable cable head **10**. The cable **12** is inserted in the releasable cable head **10** through an elastomeric cap **13**. The cap **13** extends inside the housing **15**. Commonly, the cap **13** is sized to be compressed around the cable **12** as the cap **13** is inserted in the housing **15** thereby acting as a seal against the entry of wellbore fluid into the housing **15**. The housing **15** is commonly filled, after

assembly, with a non-conductive grease **41** through the fill port **40**. Alternatively, a non-conductive oil may be used. The end of wireline cable **12** is terminated and captured with a conventional full-armor cone **52** and a basket **50** assembly. Alternatively, any suitable cable termination known in the art may be used. The basket is threadedly connected to the release sleeve **51**. The release sleeve **51** is connected to the latching assembly **17** and is releasable under remote electrical control from the surface.

The latching assembly **17** (see **Fig. 3A,3B**) comprises a restraining sleeve **54** fixedly attached in the housing **15**. The sleeve **54** transfers wireline tension loading to the housing through the shoulder **57**. The sleeve **54** has an annular groove **60** (see **Fig. 3B**) on an inner surface. The release sleeve **51** has a plurality of radial through holes **58** arranged around a circumference such that the holes **58** are juxtaposed with the annular groove **60** when the release sleeve **51** is inserted in the restraining sleeve **54**. Both the holes **58** and the annular groove **60** are sized to accept the ball locking elements **53**. In the locked position(see **Fig. 3A**) , the balls **53** are captured between the restraining sleeve **54** and the release sleeve **51** by the locking sleeve **70**. The number, size, and material of the balls **53** are determined, using techniques known in the art, such that the shear strength of the balls substantially exceeds the tensile strength of the cable **12**. Alternatively, the locking elements may be axially aligned rollers with appropriately shaped holes in the release sleeve.

The locking sleeve **70** is forced into the locked position by the spring **55** that extends around a reduced diameter portion of locking sleeve **70**. The reduced portion of the locking sleeve **70** extends through an annular solenoid coil **56** disposed in the housing sleeve **54**. When energized (see **Fig. 3B**), the solenoid **56** magnetically interacts with the locking sleeve **70** to retract the locking sleeve **70**, compressing the spring **55** and allowing the balls **53** to move inwardly. This action releases the cable **12** from latching the assembly **17**, and allows the cable to be retrieved to the surface. The solenoid **56** may be potted using a suitable

material such as an epoxy or elastomeric potting compound to protect the solenoid from contaminants. The electrical conductors **80** are routed through the passage **71** and connected to the connectors **72** at the pressure sealed bulkhead **73** (see **Fig. 2**) for connection and operation of at least one downhole tool. Power to actuate the solenoid **56** is provided by an electronics controller (not shown) through the connector **42**. The connectors **72** and **42** are pressure sealed against intrusion of downhole fluids by use of o-rings and elastomeric boots known in the art. Such connectors are well known in the art and are commercially available. The electronics controller may be located in an atmospheric pressure sealed chamber **35** in the cable head **10**. Alternatively, the electronics may be located in a separate module (not shown) connected between the cable head **10** and the tool string **18**. Electrical power and communications signals are fed through the conductors **80** and passed through the electronics controller to operate the tools in the tool string **18**.

In another preferred embodiment, see **Figure 4**, a cable **112** is terminated in the termination **150**. Electrical conductors **152** carried in cable **112** are connected to connectors **153** for transmitting power and/or signals to a controller (not shown) similar to that described previously. The termination **150** is mechanically connected through the tensile link **151** to the release anchor **120** that has an annular groove **123** and a flange **122**. Multiple locking fingers **121** are hinged at the hinge pins **124** and arranged to engage the anchor head **122**. The fingers **121** are forced to remain engaged with the anchor head **122** by the locking sleeve **154** that is held in position by the spring **125**. When the solenoid coil **156** is actuated, the locking sleeve **154** is retracted, compressing the spring **125** and releasing the restraint around the fingers **121**. The fingers **121** are allowed to pivot outward, releasing the anchor **120** and allowing the cable **112** to be retrieved to the surface. Alternatively, the locking fingers **121** may be flexible, non-hinged collet-type fingers (not shown) of a type common in the art.

A tensile link **151** is used as a fail-safe device in case of failure of the electrically

operated release. Such a fail-safe link may be incorporated in any of the preferred embodiments described herein.

In the preferred embodiments described above, a solenoid has been used to retract a sleeve to release a cable. Alternatively, an electric motor (not shown) may be used through a suitable mechanical drive, such as a ball-screw mechanism (not shown), to retract the release sleeve in the preferred embodiments.

The foregoing description is directed to particular embodiments of the present invention for the purpose of illustration and explanation. It will be apparent, however, to one skilled in the art that many modifications and changes to the embodiment set forth above are possible without departing from the scope of the invention. It is intended that the following claims be interpreted to embrace all such modifications and changes.